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TOPOLOGICAL STABILITY OF MAGNETIC DOMAINS IN PATTERNED COBALT ELLIPSES

P. J. Bedrossian and B. Law, Lawrence Livermore National Laboratory, Livermore CA 94551

Using a combination of magnetometry and magnetic force microscopy on arrays of non-interacting, micron-scale ellipses patterned photolithographically and etched from 70 nm-thick, sputter-deposited Co films, we observe a correlation between the presence or absence of hysteresis in the magnetization loop and the topological stability of the simple combination of vortices and stagnation points associated with the remanent state for each elliptical geometry. Magnetization along the hard axis of 2x4, 4x8, 2x8, and 4x16 μm ellipses results in no detectable hysteresis, while the remanent state in each case exhibits closure domains but is topologically equivalent to the uniformly magnetized state. Magnetization along the easy axis of 2x4 and 4x8 μm ellipses does result in hysteresis, and the respective remanent states are topologically inequivalent to the uniformly magnetized state, although they also exhibit closure domains. The presence of hysteresis in these patterned films is therefore associated with the abrupt nucleation of domains, while non-hysteretic magnetization loops are associated with continuous deformation of the local magnetization within an ellipse. The configuration of topological defects that comprise the remanent state depends on the size and the shape of the ellipses. The magnetization data can be used to extract bounds on the formation energy of the observed pattterns of domain walls and vorticies.

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Authors on abstract:
P. J. Bedrossian
B. Law

Corresponding Author:
P. J. Bedrossian
Lawrence Livermore National Laboratory
PO Box 808; L-395

email: bedrossian1@llnl.gov
Phone: (510)-423-5938
Fax: (510) 422-8761